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ABSTRACT:

CHG DATE=19990617 STATUS=O> A PTC thermistor device comprises at least two flat bodies (20,22) of PTC material, the bodies being connected electrically in series and being in thermal contact with each other. The device is able to withstand greater surge currents than a single body of the

same material of
equivalent overall size. <IMAGE>

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(54) Thermistor.

(57) A PTC thermistor device comprises at least two flat bodies (20,22) of PTC material, the bodies being connected electrically in series and being in thermal contact with each other. The device is able to withstand greater surge currents than a single body of the same material of equivalent overall size.

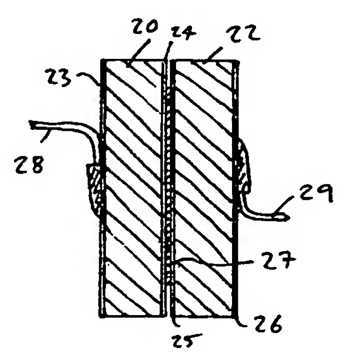

Figure 2

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This invention relates to a thermistor with a positive temperature coefficient (or PTC thermistor) able to withstand greater surge currents than prior art thermistors of similar type.

A PTC thermistor exhibits a resistance which is relatively low below a predetermined temperature, but which increases rapidly by several orders of magnitude above that temperature. One important application of PTC thermistors is to the protection of electrical and electronic equipment against high voltages and/or heavy currents which may arise under fault conditions. Thus, a PTC thermistor is connected in series with the equipment to be protected and under normal conditions, because its resistance is low, has no effect upon the operation of the equipment. However, in the event of a fault which causes an excessive current to flow, the thermistor heats up and its resistance increases rapidly to the higher value, thus reducing the current to a safe level. Once the fault is cleared, the thermistor cools and effectively resets itself to its lower resistance value.

A fault may occur abruptly, in which case the protective thermistor may be subjected to a heavy initial current surge, which it must be able to withstand.

A known type of PTC thermistor comprises a flat body of semiconducting ceramic material (e.g. in the shape of a disc) provided with conducting electrodes over its opposite faces: electrical contact is made to the electrodes either by soldering wires to them or by means of sprung pressure contacts.

When subjected to a large surge current, a ceramic PTC thermistor heats up in a non-uniform manner, with the material at the middle of a disc-shaped element heating up more rapidly than the material adjacent the opposite flat faces or adjacent the peripheral edge. This non-uniform heating causes non-uniform thermal expansion which in turn gives rise to mechanical stresses: if these stresses are excessive, the ceramic body fractures and the device fails. Also, it has been found that the larger the potential that is developed across the middle region of the device, as in the case of a high supply or fault voltage, the greater is the rate of localised heating in this region and therefore the greater is the risk of fracture.

It has been found in practice that the maximum surge current density, which a ceramic PTC thermistor can withstand in a high voltage circuit without failing, decreases as the thickness of the element increases, relative to its diameter. Hitherto this has limited the ability to provide a ceramic thermistor thick enough to withstand a high voltage whilst at the same time capable of withstanding a high surge current.

We have now devised a PTC thermistor device which overcomes these difficulties.

In accordance with this invention there is provided a PTC thermistor device which comprises at least two flat bodies of PTC material which are connected electrically in series and which are in thermal contact with each other.

Preferably the flat bodies of PTC material are disposed face-to-face with each other. Preferably the opposite faces of each PTC body are provided with conducting electrodes. The adjacent faces of the or each pair of PTC bodies may be bonded together by means of an electrically and thermally conducting composition e.g. solder: preferably the layer of bonding composition terminates short of the peripheral edges of the PTC bodies.

We have found that PTC thermistor devices in accordance with this invention are able to withstand a higher surge current than devices consisting of a single body of the same PTC material and of the same cross-section and thickness.

Embodiments of this invention will now be described by way of examples only and with reference to the accompanying drawings, in which:

FIGURE 1 is a section through a prior art PTC thermistor;

FIGURE 2 is a section through a first embodiment of PTC thermistor in accordance with this invention; and

FIGURE 3 is a section through a second embodiment of PTC thermistor in accordance with this invention.

Referring to Figure 1 of the drawings, there is shown a prior art ceramic PTC thermistor, comprising a flat disc 10 of PTC semiconductor material, specifically a barium titanate ceramic which is doped to render it semiconducting. The opposite flat faces of the disc 10 are provided with metallic electrodes 11, 12, deposited for example by a sputtering process. Terminal wires 13, 14 are connected to the electrodes 11, 12 by soldering.

Figure 2 shows a thermistor device in accordance with this invention, comprising two flat discs 20, 22 of the ceramic PTC semiconductor material, each disc being provided with metallic electrodes 23, 24 and 25, 26 over its opposite faces. The two discs 20, 22 are bonded together face-to-face by a layer of solder 27, which preferably terminates short of the peripheral edges of the discs. Terminal wires 28, 29 are soldered to the outer electrodes 23, 26 of the composite device.

The overall thickness of PTC material between the outer electrodes 23, 26 determines the maximum voltage which the device is able to withstand. Because the two discs are in thermal contact, any tendency is avoided of one disc heating up significantly quicker than the other and therefore adopting its high resistance on its own. We have found, however, that the device of Figure 2 is able to withstand a significantly greater surge current than a device of Figure 1 having the same diameter and overall thickness. One possible reason for this is that the provision of electrodes (24, 25) within the device leads to a more uniform distribution of current through the ceramic

bodies, and therefore more uniform heating resulting in less mechanical stress. Another possible reason is that because the discs comprise a quantity of powder which has been pressed and then sintered, the density and resistivity of the ceramic material may be more uniform in a thin disc than in a thick disc, leading to a more uniform temperature distribution when subjected to a fault current.

Further, a degree of radial movement of one disc relative to the other may occur, in the device of Figure 2, particularly as the layer of solder 27 terminates short of the peripheral edges of the discs. Thus, it is possible for one disc to heat and expand more rapidly than the other, without creating excessive mechanical stress within either disc.

Whilst the device of Figure 2 comprises two discs disposed face-to-face in thermal contact and connected electrically in series, the device may comprise any number of discs mounted in a stack, such as three discs 30, 32, 34 as shown in Figure 3.

Whilst Figures 2 and 3 show devices comprising discs, flat PTC ceramic bodies of any alternative cross-sectional shape may be employed.

Also, whilst Figures 2 and 3 each show flat ceramic bodies provided with electrodes over their opposite faces and then bonded together, they may instead be mechanically clamped together e.g. under spring pressure.

Claims

1) A PTC thermistor device which comprises at least two flat bodies (20,22) of PTC material, said bodies being connected electrically in series and being in thermal contact with each other.

2) A PTC thermistor device as claimed in claim 1, in which the flat bodies (20,22) of PTC material are disposed face-to-face with each other.

3) A PTC thermistor device as claimed in claim 2, in which the opposite faces of each body (e.g. 20) of PTC material are provided with conducting electrodes (23,24).

4) A PTC thermistor device as claimed in claim 2 or 3, in which the adjacent faces of adjacent bodies of PTC material are bonded together by an interposed layer (27) of an electrically and thermally conducting composition.

5) A PTC thermistor device as claimed in claim 4, in which the layer (27) of bonding composition terminates short of the peripheral edges of the bodies (20,22) of PTC material.

6) A PTC thermistor device as claimed in claim 2 or 3, comprising clamping means acting to mechanically clamp together the flat bodies of PTC material.

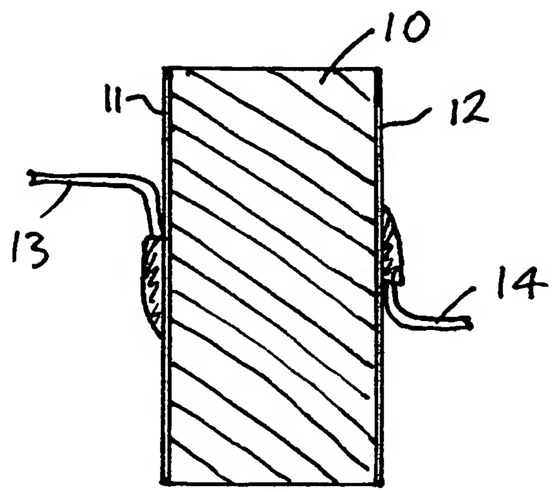

Figure 1

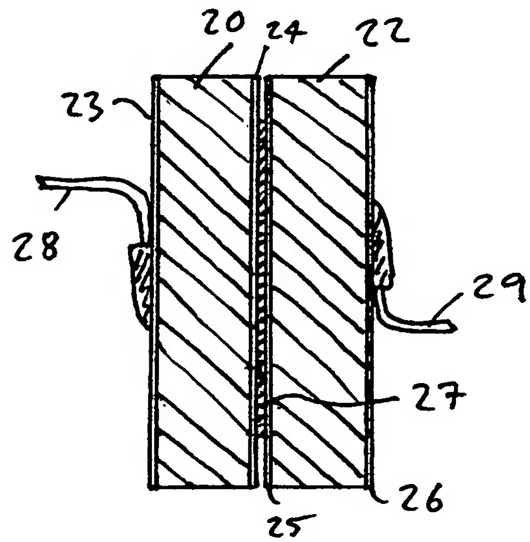

Figure 2

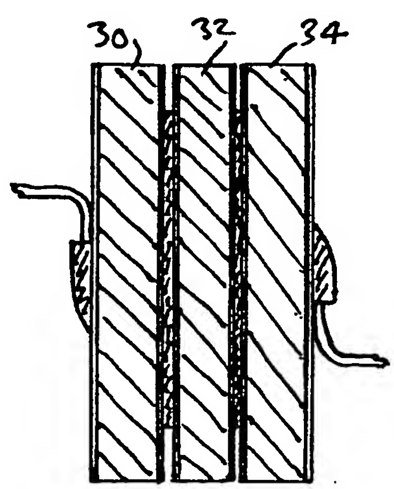

Figure 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number

EP 92 30 8746

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
X	DE-A-3 905 443 (MURATA MFG) * the whole document * ---	1-4	H01C1/14 H01C13/02 H01C7/02
X	US-A-4 259 657 (ISHIKAWA ET AL.) * the whole document * ---	1,2	
X	PATENT ABSTRACTS OF JAPAN vol. 5, no. 110 (P-71)17 July 1981 & JP-A-56 053 429 (MATSUSHITA ELECTRIC) 13 May 1981 * abstract * ---	1	
A	PATENT ABSTRACTS OF JAPAN vol. 13, no. 352 (E-801)8 August 1989 & JP-A-01 110 701 (MURATA MFG) * abstract * -----	1,6	
			TECHNICAL FIELDS SEARCHED (Int. Cl.5)
			H01C

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	21 DECEMBER 1992	PUHL A.T.

CATEGORY OF CITED DOCUMENTS

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